Autonomous Ocean Sampling Network II (AOSN-II): System Engineering and Project Coordination

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LONG-TERM GOALS

The long-term goals of this project are to design and build and Adaptive Coupled Observation/ Modeling Prediction system. The system will use oceanographic models to assimilate data from a variety of platforms and sensors to provide synoptic views of oceanographic fields, fluxes, and dynamical processes. The system will adapt assets and sampling strategies to enhance system performance and optimize detection and measurement of fields and features of particular interest. We refer to such a system as an Autonomous Ocean Sampling Network (AOSN). The work described below is the product of a collaboration of research groups at the Monterey Bay Aquarium Research Institute (MBARI), Harvard University, the Jet Propulsion Laboratory (JPL), the Naval Postgraduate School-Monterey (NPS), the University of Southern Mississippi (USM), the Naval Research Lab-Monterey (NRL-MRY), the Naval Research Lab-Stennis (NRL-Stennis), Princeton University, California Institute of Technology-Pasadena (Cal Tech), Woods Hole Oceanographic Institute (WHOI), California Polytechnic State University (Cal Poly), the University of California Santa Barbara (UCSB), the University of California Santa Cruz (UCSC), the University of California Los Angeles (UCLA), the University of Maine, and the Harbor Branch Oceanographic Institute (HOBI). System engineering and project coordination efforts are discussed most fully here. Major components of the collaboration were funded separately and covered in greater detail in separate annual reports.

OBJECTIVES

The objective of this project is to assemble components, each the result of many years of independent research conducted within the collaborating institutions, into an Adaptive Coupled Observation /Modeling Prediction System. The System will provide large quantities of detailed synoptic field estimates obtainable in no other way. It will make possible the rapid advancement of interdisciplinary ocean science and enable powerful new methods for efficient ocean management and maritime operations. System performance will be tested in a quantitative fashion and the results of those tests will be used to guide research and development to improve System performance.

APPROACH

This project is coupled with a series of science-driven experiments, each chosen to focus technology development and to convincingly demonstrate new capabilities. The System will include:

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14. ABSTRACT

The long-term goals of this project are to design and build and Adaptive Coupled Observation/ Modeling Prediction system. The system will use oceanographic models to assimilate data from a variety of platforms and sensors to provide synoptic views of oceanographic fields, fluxes, and dynamical processes. The system will adapt assets and sampling strategies to enhance system performance and optimize detection and measurement of fields and features of particular interest. We refer to such a system as an Autonomous Ocean Sampling Network (AOSN). The work described below is the product of a collaboration of research groups at the Monterey Bay Aquarium Research Institute (MBARI), Harvard University, the Jet Propulsion Laboratory (JPL), the Naval Postgraduate School-Monterey (NPS), the University of Southern Mississippi (USM), the Naval Research Lab-Monterey (NRL-MRY), the Naval Research Lab-Stennis (NRL-Stennis), Princeton University, California Institute of Technology-Pasadena (Cal Tech), Woods Hole Oceanographic Institute (WHOI), California Polytechnic State University (Cal Poly), the University of California Santa Barbara (UCSB), the University of California Santa Cruz (UCSC), the University of California Los Angeles (UCLA), the University of Maine, and the Harbor Branch Oceanographic Institute (HOBI). System engineering and project coordination efforts are discussed most fully here. Major components of the collaboration were funded separately and covered in greater detail in separate annual reports.

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- Oceanographic models from Harvard University, JPL, and USM.
- Observation assets from WHOI, MBARI, and NPS.
- Adaptive Sampling solutions from Princeton University and Cal Tech.
- Many additional contributions from the other collaborating institutions.

The System will be operated to acquire data in support of Science Objectives defined by Scientists at MBARI, UCSB, Cal Poly, UCSC, and HOBI. Additional observations will be made to test the skill of the System.

The overarching long-term AOSN Science Objective is to use the AOSN System to provide 3-5 day forecasts of physical oceanographic parameters to support prediction of important marine biology events. For example, we hope to support prediction of bioluminescence blooms, red tides, or the health of important stages in the food chain. The AOSN-II FY02/FY03 effort will focus on the ecosystem response: physics, chemistry, and biology, including bioluminescence, resulting from the advection of cold nutrient rich upwelled water across the Monterey Bay (Upwelling Center). These Upwelling Centers commonly extend from Año Nuevo southward across the Monterey Bay in summer months. The anticipated El Niño Southern Oscillation, ENSO, event in the summer of 2003 may alter the dynamics of the Upwelling Center and permit the study of a very important oceanographic event. The AOSN-II effort may further study the California current system and its interactions with coastal circulation, biological dynamics, and advection of the Upwelling Center.

WORK COMPLETED

An AOSN-II workshop was held at MBARI during the week of 12-16 August 2002. The workshop was well attended and much was accomplished. Project coordination efforts have continued aggressively since then. Coordination documents are being prepared, circulated, revised, and re-circulated. We plan to have a System Performance Summary, Detailed Design, and Project Schedule in hand by the first of the year 2003. System research, development, integration, test cycles are planned for the first half of 2003. The AOSN-II System will be deployed in the Monterey Bay starting in mid July 2003 and tested during the month of August 2003.

RESULTS

This is a new start project that was initiated late in FY02 on 1-August-2002. Early project coordination efforts are underway.

IMPACT/APPLICATIONS

The AOSN System has the potential to provide 3-5 day forecasts of important oceanographic physical, chemical, and biological events using continuously deployed autonomous assets coupled with models. Use of adaptive coupled observation/modeling oceanographic prediction systems may someday be as commonplace as the use of atmospheric models and will perhaps have even greater impact on science due to their ability to reveal events difficult to observe in any other way. The AOSN-II project and

experiments represent the first attempt to fully integrate major components of an adaptive coupled observation/modeling prediction system into an engineered system. Project success will rely on successful coordination of many independent research efforts and the research, innovation, design, implementation, and integration of key System infrastructure technologies: Automated survey planning and mission planning tools, for example.

Individual components of the system, such as the AUVs and gliders, provide unique measurement capabilities for ongoing oceanographic field programs. The use of multiple vehicles allows synoptic surveys that would otherwise be prohibitively expensive. Perhaps most important, the work creates mobile platforms and supporting systems for extended deployment in remote (and not so remote) locations. Many Navy missions, including tactical oceanography, mine countermeasures, covert surveillance, and anti-submarine warfare will benefit from the developed technology.

TRANSITIONS

None yet.

RELATED PROJECTS

This program is the lead element of an ONR effort collaboratively linked with the following ONR funded efforts:

Dynamics of Oceanic Motions (6.1), Prof. Allan Robinson, Harvard University, ONR Award Number N000149510371

Development of a Regional Coastal and Open Ocean Forecast System (6.2), Prof. Allan Robinson, Harvard University, ONR Award Number N000149710239

High Resolution Measurements of Coastal Bioluminescence, Dr. Steven Haddock, MBARI.

Use of a Circulation Model to Enhance Predictability of Bioluminescence in the Coastal Ocean, Igor Shulman, USM, et.al. ONR Award Number N00014-02-1-0852.

Aerial Surveys of the Ocean and Atmosphere off Central California, Prof. Steven R. Ramp, NPS, et.al., ONR Award Number N0001402WR20393.

Underwater Glider Networks for Adaptive Ocean Sampling, Prof. Naomi Leonard, Princeton University, et.al.

An Autonomous Glider Network for the Monterey Bay Predictive Skill Experiment / AOSN-II, Dr. David M. Fratantoni, WHOI, ONR Award Number N00014-02-1-0846

Development of Oceanographic Sampling Networks Using Autonomous Gliding Vehicles. Dr. David Fratantoni, WHOI, ONR Award Number N00014-00-1-0256

Development of a Monterey Bay Forecasting System Using The Regional Ocean Modeling System (ROMS), Dr. Yi Chao, JPL, et.al.

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Paduan, J., Ramp, S., Bahr, F., Cook, M., Frye, D., Koski, P., Chavez,, F., Reid, F., and Bluth, R., "Atmospheric Forcing and Oceanic Response During Late Summer Upwelling and Relaxation Events in Monterey Bay," Presented at: The Oceanography Society Biennial Scientific Meeting, Miami, FL, April 2-5, 2001.

PUBLICATIONS

None

PATENTS

None.